

Preface

The book is intended to provide researchers and engineering practitioners in fluid flows with a state-of-the-art knowledge in continuum concepts and the associated fluid dynamics. It further exploits the implicit link between the turbulent flow of classical Newtonian fluids and the laminar and turbulent flow of non-Newtonian fluids needed in many applications such as food processing and polymeric flows. The underlying basis of the presentation will be primarily continuum modeling and will focus on tensorial constitutive relations needed to solve complex flow situations. The notion of complexity will be defined for both the fluids and the flows, and the interplay between the observed phenomena and the capabilities offered by the continuum theory will be highlighted where possible.

The reader is assumed to have a basic knowledge in standard continuum and fluid mechanics, that is, tensor algebra, and basic concepts of kinematics or dynamics of the fluid and flow stress tensor. The monograph will present the mathematical foundation to write meaningful constitutive equations and relevant fluid flow models. These equations are nonlinear most of the time and quite complicated to solve. In order to aid in the clarity, an effort has been made to conserve the usual topical mathematical notation within the complex fluid (viz. the continuum mechanics) and complex flow (viz. turbulent dynamics) communities. The solution methods require numerical methods and algorithms. However, this book does not address this topic as it deserves by itself a full manuscript. We refer the reader to the available specialized literature that covers these subjects.

The presentation of the material will range from the fundamental to the practical. For the fundamental, a focus on kinematic and dynamic considerations will prevail and related to the formation of constitutive relations for the fluid and flow stress fields. For the practical, current methods of solution including the direct numerical simulation, the scale-resolving simulation and the Reynolds-averaged method will be presented for both the Newtonian and non-Newtonian fluids. Some discussion will be presented on emerging technologies associated with multi-scale methods and a resurgence of the lattice-Boltzmann method.

Although numerical simulations are rapidly becoming the main tools for technological innovation and novel design, the book is aimed at the mathematical methodologies for the development of theoretical models needed to incorporate the requisite

physics, that in modern engineering, has to be predicted and understood before any manufacturing is involved. Important technologies associated with the global solutions for ground and air transportation including vehicular drag reduction, noise generation, and cabin ventilation and acoustics, are dependent on these models. Equally, or possibly more, important are the technologies associated with the understanding, and possible prediction, of the global environment.

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